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AN INDUSTRIAL WASTE GUIDE TO THE COMMERCIAL LAUNDERING INDUSTRY

Public Health Service
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Commercial Laundering Industry

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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

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ERRATA SHEET

for

P. H. S. Publication No. 509

"an Industrial Waste Guide to the Commercial Laundering Industry"

Please make the following corrections:

1. Page 4, column 2, para 2, line 5, change "testing of pieces." to "test pieces."

2. Page 5, column 1, line 7, change "laundries." to "laundering."

3. Page 5, column 1, line 8, insert "other" after "and" and delete "done".

4. Page 8, delete first sentence and insert therefor "Surface waters can be contaminated by laundry wastes due to soil, lint, residual soap, alkali, starch, and other washable supplies normally present in such waste water.

5. Page 8, Reference 9, line 2, delete "Room" and change "Laundries" to "Laundry".

I

an Industrial Waste Guide to the

Commercial Laundering Industry

Details of illustrations in this document may be better studied on microfiche

Prepared by the Stream Pollution Abatement Committee of the American Association of Textile Chemists and Colorists, in Cooperation with the American Institute of Laundering

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service — Bureau of State Services

Division of Sanitary Engineering Services

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II-b

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Foreword

In the Commercial Laundering Industry, as in many other industries, control and disposal of wastes is of major concern. There are two important reasons for increased attention to these problems: First, the need for reducing wastes in order to permit the most economical operation in small as well as large plants; second, the need for protecting the Nation's limited water resources for maximum use essential to health and continued economic growth. Stream pollution control is mutually beneficial to industry, the individual citizen, and the Nation as a whole. Thus, wastes which cannot be eliminated must be disposed of in a manner which will not impair the usefulness of stream waters for other beneficial purposes.

This "Industrial Waste Guide to the Commercial Laundering Industry" is intended primarily to aid operators in their water pollution control program. It will be useful in informing consultants and personnel of regulatory agencies of the source and characteristics of laundry wastes and the status of waste treatment development. The guide was prepared by the Stream Pollution Abatement Committee of the American Association of Textile Chemists and Colorists, which is the technical association of the textile wet-processing industry, in cooperation with the American Institute of Laundering. It was submitted for publication to the Public Health Service through the National Technical Task Committee on Industrial Wastes.

The National Technical Task Committee on Industrial Wastes is composed of representatives from the Nation's leading industries concerned with solving difficult industrial-waste problems. The objective of the organization is to perform technical tasks pertaining to industrial wastes in cooperation with the Public Health Service and all others concerned with improving the quality of our water resources. The preparation of this Guide was one of the tasks assumed by the Textile Industry in carrying out this objective.

This is the fourth of a series of Industrial Waste Guides prepared by the National Technical Task Committee in cooperation with the Public Health Service.

Commercial Laundering Industry

Introduction

The washroom supervisor occupies a key position in reducing the polluting effects of his washroom effluents. He can be particularly effective in the area of good washroom processing control, since such control will prevent waste at the source and at the same time reduce processing costs. This handbook is designed to assist him in exercising his responsibility for waste reduction and pollution control, and in recognizing those additional problems which require the services of the plant chemist and plant engineer.

Waste technologists and others in the Commercial Laundering Industry have attempted to make this handbook a concise practical guide for operation of washrooms with a minimum of wastes. This booklet summarizes information made available over a period of time by many investigators. It emphasizes the appreciable reduction of waste which can be accomplished by preventing overuse of washing agents such as soap, alkali, etc., and control of washer loads.

The section on waste treatment contains sufficient information to suggest possible solutions to stream-pollution problems which cannot be adequately corrected by waste-reduction procedures. Some performance data are included on various waste treatment processes. This section may also serve to emphasize the value of waste reduction methods in lowering total waste treatment costs.

Description of Process

The washers used by commercial laundries are horizontal perforated cylinders mounted inside stationary shells and provided with inlets for hot and cold water and outlets for the waste water. The clothes to be washed are placed in the perforated cylinder together with water and soap or other washing agents. The soap and other agents such as bleaching compounds, alkali, etc., are referred to as "Supplies." Rotation of the inner cylinder produces agitation necessary to free or dissolve the "soil" from the fabrics.

The method of washing used in commercial laundries is commonly known as the multiple sub formula. Typical washing formulas of this type for white and colored work are given in tables 1 and 2. The multiple sub formula calls for giving a washer load a series of sudsing, rinsing, and other required operations, such as bleaching, souring and bluing, without removing the clothes from the washer. Fresh water, along with the required detergents or other supplies, is added at the beginning of each operation and the washer drained at the end of each operation. The total amount of water present in the washer on a sudsing operation is approximately 0.5 gallon per pound of clothes. On a rinsing operation this is increased to 0.75 gallon per pound. In either case, after draining at the end of an operation, the load retains about 0.25 gallon per pound of dry load. This procedure gives a relatively low ratio of water to load on any single operation, but in this method of washing each operation produces a dilution of the water retained by the load from the one which preceded it, so that the final rinse water will have an alkalinity closely approaching that of the incoming fresh water. The total water consumption with this method of washing will be about four gallons per pound of clothes. A detailed discussion of this and other methods used in commercial laundry washrooms is given by Smith (9).

TABLE 1.—*Typical laundry white work formula*

(Water and washing supplies based on 100-pound load)

Bath	Inches water in cylinder	Gallons water	Temperature °F.	Running time minutes	Supplies
First suds	6 to 8	54 to 58	100 to 120	7 to 10	8 to 16 ounces alkali.
Second suds	5 to 7	21 to 26	115 to 130	5 to 10	5 to 8 ounces soap.
Third suds	5 to 7	21 to 26	130 to 140	5 to 10	2 to 4 ounces soap.
Fourth suds and bleach	5 to 7	21 to 26	140 to 160	7 to 10	1 to 2 ounces soap.
First rinse	12	39	150 to 165	5	2 quarts 1 percent bleach no soap or alkali.
Second rinse	12	39	150 to 165	5	
Third rinse	12	39	150 to 165	5	
Fourth rinse	12	39	130 to 140	5	
Sour and blue	5 to 10	33	100 to 110	5 to 5	1 to 2 ounces sour plus blue.

TABLE 2.—*Typical laundry colored work formula*

(Water and supplies used based on 100-pound load)

Bath	Inches water in cylinder	Gallons water	Temperature °F.	Running time minutes	Supplies
First suds	6 to 8	54 to 58	100 to 110	7 to 10	8 to 16 ounces alkali.
Second suds	5 to 7	21 to 26	100 to 120	5 to 10	6 to 10 ounces soap.
Third suds	5 to 7	21 to 26	100 to 120	5 to 10	3 to 5 ounces soap.
First rinse	12	39	100 to 120	5	2 to 3 ounces soap.
Second rinse	12	39	100 to 120	5	
Third rinse	12	39	100 to 120	5	
Fourth rinse	12	39	100 to 120	5	
Sour	5	21	90 to 100	5	1 to 2 ounces sour.

Washing Formulas

White work washing formulas, in most laundries, have the same basic pattern but vary in detail from one plant to another due to local conditions. The amount of alkali used varies with the type and amount of soil content and the present tendency is to use alkalies such as sesqui or orthosilicate which have low buffering values. The quantity used generally gives a pH of 11.0 to 11.5 on the first operation, with a total alkalinity corresponding to not more than 2.5 ml. of normal acid per 100 ml. of solution. The fresh water added on each of the succeeding operations causes a progressive dilution, so that the final rinse bath will commonly contain not more than twice the alkalinity present in the tap water used in the process.

The soap used in white work washing formulas is usually a 42° tire tallow soap and the amount and type of alkali required will vary with the soil content of the fabrics being processed and the hardness of the water used.

Sodium hypochlorite is almost always used for bleaching although in a few cases it may be replaced with peroxide. The amount used is strictly controlled and a composite laundry waste water sample can, in all cases, be expected to give a negative test for available chlorine.

There are five fluorides which are commonly used as sours either singly or in combination. These are sodium acid fluoride, ammonium acid fluoride, sodium silicofluoride, ammonium silicofluoride and zinc silicofluoride. There are a few plants which use acetic acid.

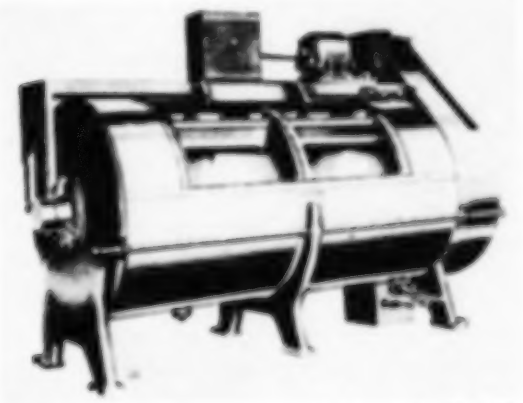
Starch, which is not indicated in the white work formula, is sometimes used in small amounts on white flat work and is commonly used on shirt loads.

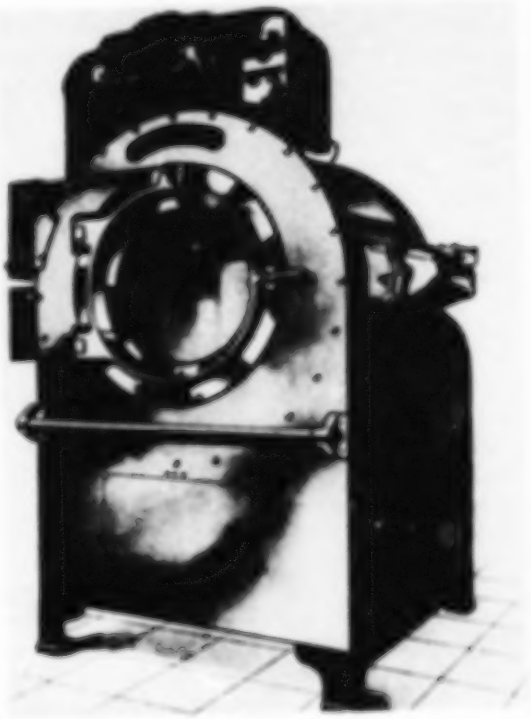
The blues used are fugitive dyes. The quantity used is so small that it is of no importance from a waste water standpoint.

Colored work formulas are run at varying temperatures depending on the color classification being processed but the temperatures will usually fall within the 100° to 120° F. range.

The alkalies used will have higher buffer values than those used for white work and the maximum pH shown by a colored work load will seldom be more than 10.6.

The use of soaps having a titer of 20° to 35° has been standard practice in colored work washing for many years, but recently there has been a growing tendency to substitute built synthetics for such soaps. Colored work on the average contains more soil than white work and the soap consumption will therefore be higher.





Figures 1a, 1b.—Typical laundry wash wheels.

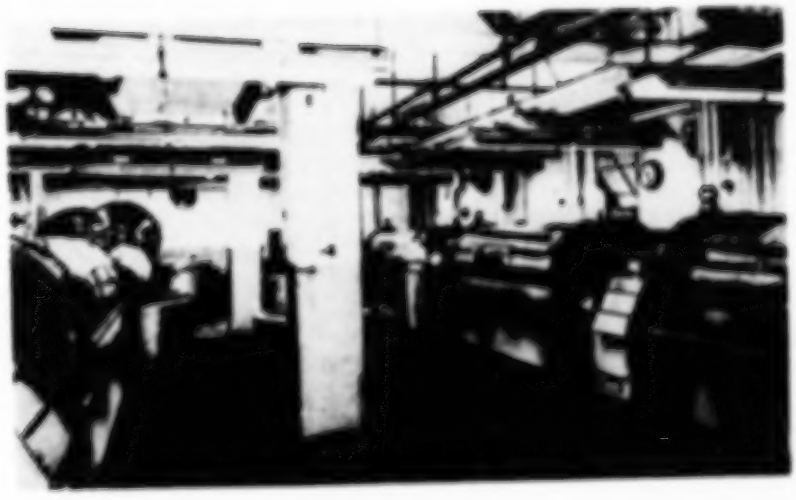


Figure 2.—Laundry wash room view.

Laundry Waste Water Treatment

Characteristics of Wastes

Laundry waste water contains the soil removed from the washed clothes along with the residual washing supplies. The soap or other detergent present in the water produces a rather permanent suspension of the soil and lint so that even after prolonged standing, during which considerable bacterial decomposition will take place, there is only a partial separation of the solids. The detergent efficiency of soap and many other surface active agents is increased by the use of alkalis such as sodium carbonate, trisodium phosphate and the alkaline silicates. Caustic soda is used only to a limited extent and then generally in conjunction with less active alkalis which act as buffering agents. Complex phosphates and sequestering agents are also used to a limited extent as water softeners and to aid in stripping soap from the fabric.

Most laundries use soap as a detergent in washing white and colored cottons but a very few plants are using either anionic or non-ionic detergents for this purpose and many use synthetic detergents for washing wool and specialty items. In the aggregate, however, the amount of synthetic detergent used is small in relation to that of the true soaps.

Commercial laundries, for reasons of quality and economy, generally soften the water used for washing when the incoming raw water has a hardness in excess of 4–5 grains per gallon, so that in general, soap usage is not materially effected by variations in the hardness of the raw water. There are, however, other factors which do produce appreciable variations in the required use of soap and other washing supplies, the most important of which are:

1. The amount of soap and alkali required to give a good detergency is directly related to the amount and type of soil present in the clothes.

2. The average size of the loads washed with relation to the capacities of the washers used will produce different dilution ratios and supply usage.

3. The bicarbonate content of the raw water will directly affect the composition of the waste water and where high bicarbonate waters are used this factor will tend to increase alkali usage.

4. The type and quantity of washroom supplies, other than soap and alkali, such as sours, starches, synthetic detergents, etc.

The above factors produce distinct variations in the average composition of laundry waste waters.

Waste Reduction

As explained in the preceding section on the characteristics of the wastes, the quantity of materials in the wastes are affected by washroom practice. In particular, the usage of washroom supplies per pound of clothes washed and washer loading practice are important.

The best type and the minimum quantity of washroom supplies which will give satisfactory results in any particular washing formula can be established by titration, pH measurement, observation of suds level and testing of pieces. Once a proper usage has been established by test procedure then an adequate system of supply measurement, along with careful supervision must be maintained to insure that proper and minimum quantities of supplies will be used in regular washroom operation. Such a procedure will not only reduce waste problems but will pay dividends in reduced supply costs.

The underloading of washers results in the increased usage of both water and supplies per pound of clothes washed. Special effort should be made to wash full loads wherever possible.

Composition of Laundry Waste Water

There is relatively little data to be found in the literature on the composition of laundry waste water and these data show even greater variations than might be expected from the factors listed above. This condition appears to be due, in part at least, to the use as a basis of testing, of waste samples which were composites of the various washing operations of individual washer loads and which did not represent the true average composition of all the waste water. With this method of sampling, the sample is usually taken from a white work load or other fully loaded washer where the waste water will show higher concentrations and alkalinities than in the case of colored work or specialty washing. Boyer (1) has given data as to pH, B. O. D.,[1] and the amount of acid required to neutralize samples to pH of 6.4. Eldridge (2) gives data on B. O. D. Klein (3) gives data on B. O. D. and suspended solids. Sakers and Zimmerman (4) give data on B. O. D. and total and suspended solids. Gehrs (5) gives data with respect to both domestic and commercial laundry wastes.

[1] B.O.D. = Biochemical Oxygen Demand, a term which signifies the amount of dissolved oxygen which will be taken out of the water during the decomposition and stabilization of the waste.

Snell and Fain (6) give data on the quantities of chemicals required for the clarification of laundry wastes, from which approximate values for waste water composition can be calculated.

No references have been found as to the composition of waste water from linen supply or those doing industrial laundries.

The data reported in the literature and work done indicate that most laundry waste waters will have compositions within the limits shown in Table 3.

TABLE 3.—*Typical laundry waste water composition*

pH	9.0 to 9.3.
Alkalinity above pH 7.0 as sodium carbonate	60 to 230 p. p. m.
Total solids	600 to 1,200 p. p. m.
B. O. D. (5-day demand)	400 to 850 p. p. m.

Laundry waste water undergoes decomposition on standing which results in a reduction in pH and titratable alkalinity and possible changes in other characteristics. As an example, one sample tested dropped from an initial pH of 9.3 to 7.5 during the first 24 hours.

There is little accurate data available as to the amount of laundry waste water which is either treated prior to entrance into municipal disposal systems or before disposal into streams. However, general information indicates that all but a very small percentage of the commercial laundry waste water is passed directly into municipal sewage systems without pre-treatment. Johnson (7) states: "So far as we can learn there are only a few laundries that are required to pre-treat their sewage before passing it into municipal sewage systems or streams. Those plants that are required to pre-treat their sewage have either just started the treatment or are about to start it; therefore, we do not have much information as to their methods." In New Jersey there are four laundries out of over 200 which do not dispose of their waste water by discharging into municipal sewage systems. In all other cases the laundry waste water is passed into the sewage system without any prior treatment.

Bayer (1) and Riker (2) have published data indicating that under certain conditions too high a percentage of laundry waste may slow down or make more difficult pre-treatment of the combined laundry waste and domestic sewage, but Gehm (4) states: "Laundry waste alone or combined with sewage can be readily and economically treated to any degree desired by existing physical, chemical and biological methods or by combinations or improvements of such methods." In support of this contention, it should be noted that most commercial laundry waste water is entered into the municipal sewage systems and apparently is causing little or no disturbance in the treatment plants.

Municipal systems are obligated to accept home laundry waste water, and according to Gehm (4) this represents 5 to 10 percent of the total volume of domestic sewage and has a definite peak volume on Mondays. Also, according to this same reference, the use of hard water and the overuse of soap and other detergents combine to make the home laundry waste water at least twice as concentrated as that from commercial laundries. Both the evenness of flow and the lower concentration should make the commercial laundry waste water easier to treat.

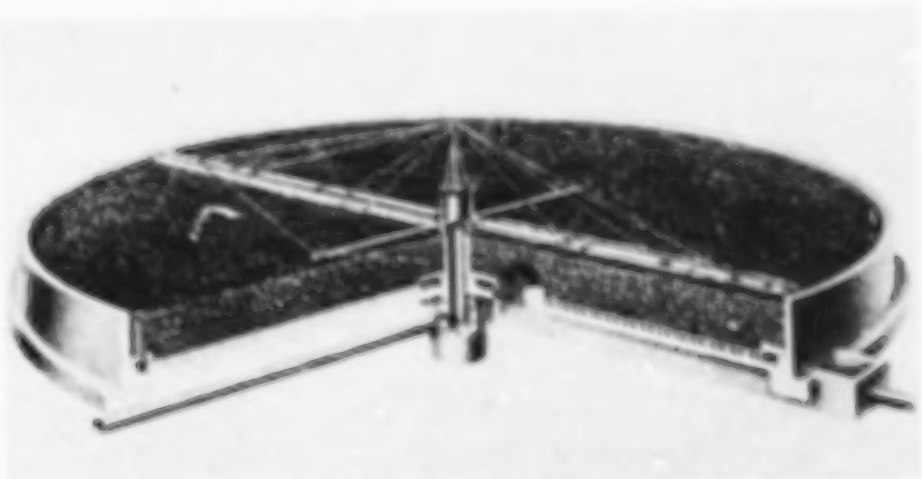


Figure 3.—Detail of trickling filter construction. The aerobic bacteria living in the slime coating on the stones "digest" the organic matter in the laundry wastes.

Methods of Waste Treatment

Where laundry waste water must be treated before being discharged to streams, it may be purified by chemical treatment followed by sedimentation and/or filtration. Boyer (1) states that excellent results can be obtained with trickling filters, but that the results on Dunbar filters are not satisfactory. Other investigators have also reported favorable results with trickling filters, but the data in the literature does not disclose the use of this method by any commercial laundry.

The relatively few laundries which are now treating their waste water are using such chemicals as sulfuric acid, calcium chloride, milk of lime, ferrous sulfate (Copperas), alum and ferric alum. Boyer (1) reports that sodium aluminate is not satisfactory. The chemicals used for treatment are preferably added either in the dry form or in solution to the waste water at some point such as the exit from the pre-heater where the outgoing waste water gives up part of its heat to the incoming clean cold water or at any other convenient point where all sources of waste water have been combined.

It has been found that the type of chemical and the dosage which will give the most satisfactory results in a treatment plant can be very accurately determined from laboratory tests on representative samples of laundry waste water. Such samples are best obtained by taking a series of small samples at regular intervals over a period of an hour or more, from the outlet drain of the washroom or the exit of the pre-heater and then combining and thoroughly mixing them. Tentative dosage requirements as developed from tests on such a composite should be checked against additional samples taken on different days of the week.

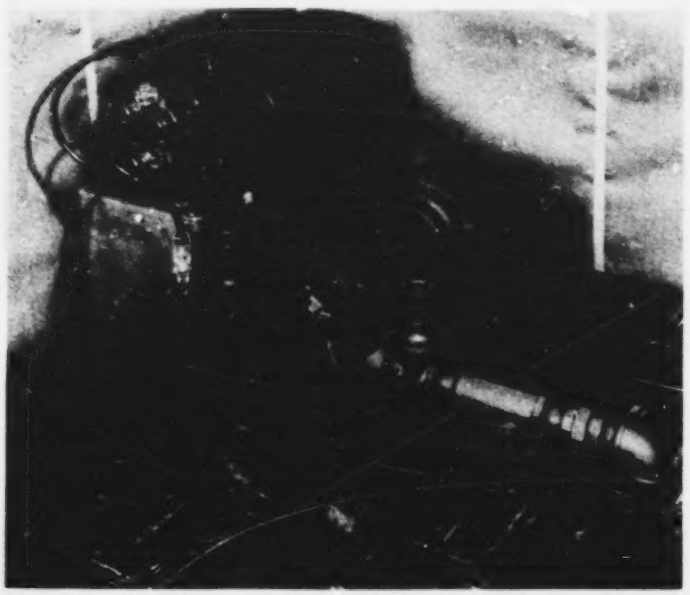


Figure 4.—Alum feeder discharging into waste line.

Procedure for Laboratory Flocculation Tests

The actual technique of such laboratory tests as used by Smith (10) is as follows:

Stock solutions of the chemicals which are to be investigated are made up in concentrations of 100 to 200 grams per liter and measured volumes of the treating solutions under test are added in small increments to 500 ml. samples of the waste water, using moderate mechanical stirring to aid in mixing and flocculation. By stopping the stirring and allowing the test sample to settle for a few minutes between additions, it is possible to determine the approximate amount of chemical which will be required.

Figure 5.—Settling pond for the precipitation of the alum floc.

Once the approximate end point has been determined, then a series of 500 ml. samples should be treated with quantities of coagulant which vary on either side of that required for the preliminary end point, and in the case of these samples the coagulant should be added slowly but continuously with moderate stirring to simulate actual plant treatment conditions. After the precipitation reaction has been completed, the samples are transferred to 500 ml. cylinders and allowed to settle. A comparison of the appearance of the floc, the rate of settling, and the volume of the settled floc, for the various samples will make it possible to determine the amount of treatment chemical required and

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to compare various coagulants as to cost and efficiency.

The amount of treatment chemical required will, in certain cases, vary with pH of the waste water and it is generally advisable to investigate the more promising types of treatments at various pH levels. Boyer (1) and Snell and Fain (6) advocate the use of a combination of alum and sulfuric acid and their data, as well as the experience of Smith (10) indicate that at the optimum pH, not only is less coagulant required, but the floc settles more rapidly and compactly. However, in cases where the initial alkalinity of the waste water is not too high, it is often cheaper and more convenient to dispense with neutralization. Tests made by Smith (10) have shown that in the case of three New Jersey laundries it was cheaper to use alum without neutralization and that the floc produced showed good separation and settling rates.

Figure 6.—A lagoon is a cheaper substitute for the clarifier and trickling filter, but requires several acres of land in order to retain wastes long enough for unassisted sedimentation and absorption of oxygen from the air.

Thorough mixing of the treatment chemicals with waste water, followed by a short period of gentle agitation, is desirable for development of the type of floc which will separate and settle well. This is probably best brought about by especially designed equipment in which the mixing is carried out mechanically. However, proper baffling or allowing the treated water to flow a reasonable distance through pipes or ditches before entering the preliminary settling tanks or ponds will often produce good results. The accumulated sludge is either periodically pumped to drying beds or carted away in a semi-fluid condition. An alternative is to provide at least two sets of primary settling ponds and to allow the sludge in one set of ponds to dry while the other set is being used for settling. The dried sludge is then removed mechanically and the ponds returned to service.

Final clarification may be obtained by lagooning for a sufficient length of time, usually at least several days, or the almost clear water from the primary or secondary settling ponds can be passed through open air sand filters. In any event, the amount and type of final treatment depends upon the ground area available and on the degree of purification required.

The chemical clarification of laundry waste water produces a marked reduction in B. O. D. Boyle (1) and Sakers and Zimmerman (4) report that the B. O. D. reduction by such a process is approximately 90 percent.

The variations in the results obtained by investigators in this field, and the differences in the methods used by laundries in treating their waste water can only mean that treatment methods must be modified in accordance with the character of the waste water. Such variations can be due to (a) differences in the amount and type of soil present in the goods laundered, (b) the amount and type of washing supplies used, or (c) the alkalinity of the waste water.

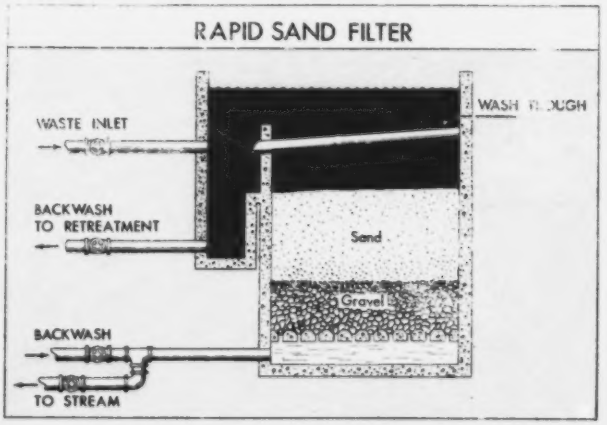

Figure 7.—Sand filters are used for the final clarification of the treated waste before discharging into the receiving stream.

Summary

Liquid wastes from commercial laundries which can contaminate water contain "soil," starch, dye traces, and lint removed from fabrics plus residuals of washing agents, alkali, and other chemicals. Appreciable waste reduction can be accomplished by avoiding overuse of washing agents and the control of washer loads in order to achieve the optimum ratio between washing agents and clothing load. A very large portion of commercial laundry wastes are discharged directly to municipal sewage systems and treated in admixture with domestic sewage. Considerable experimental work on the separate treatment of laundry wastes with trickling filters is reported in the literature. In actual practice, some laundry wastes are being treated by chemical flocculation and sedimentation. Further purification may be obtained by lagooning and sand filtration.

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